Long Term Forecast of Tsunamis

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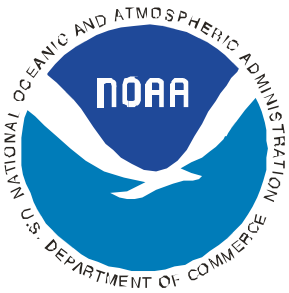
NOAA Center for Tsunami Research

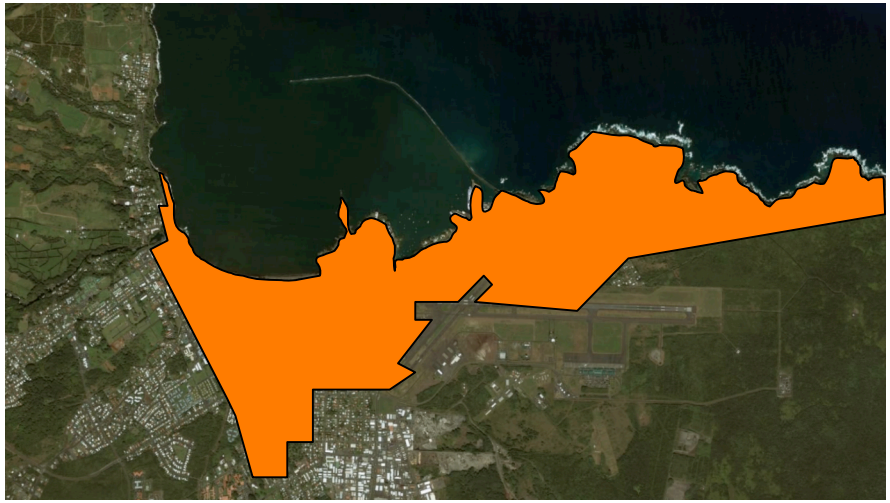
Pacific Marine Environmental Laboratory



What is Long-term Forecasting of Tsunamis?

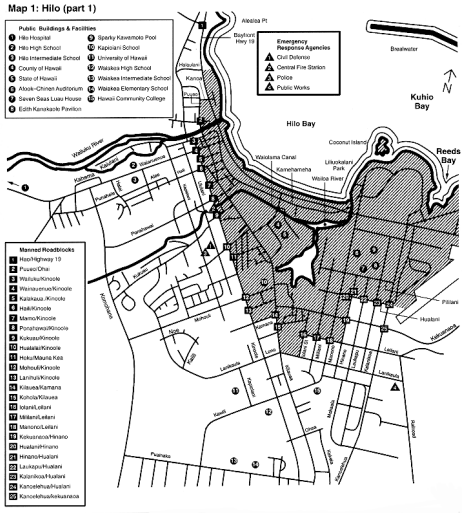
It is the use of the operational tsunami simulation model to identify the long term impact of tsunamis.

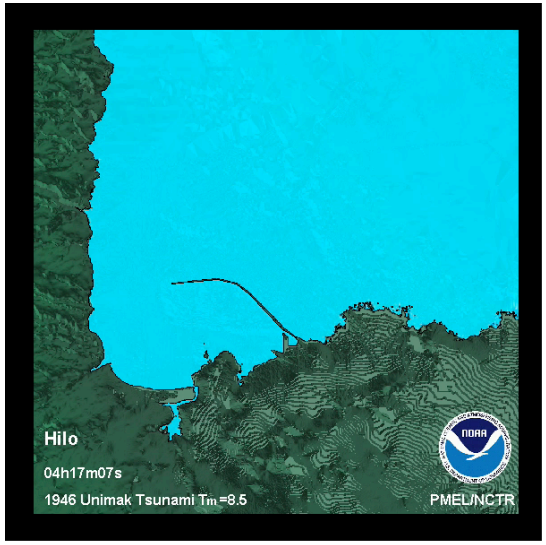
Long-term Forecast



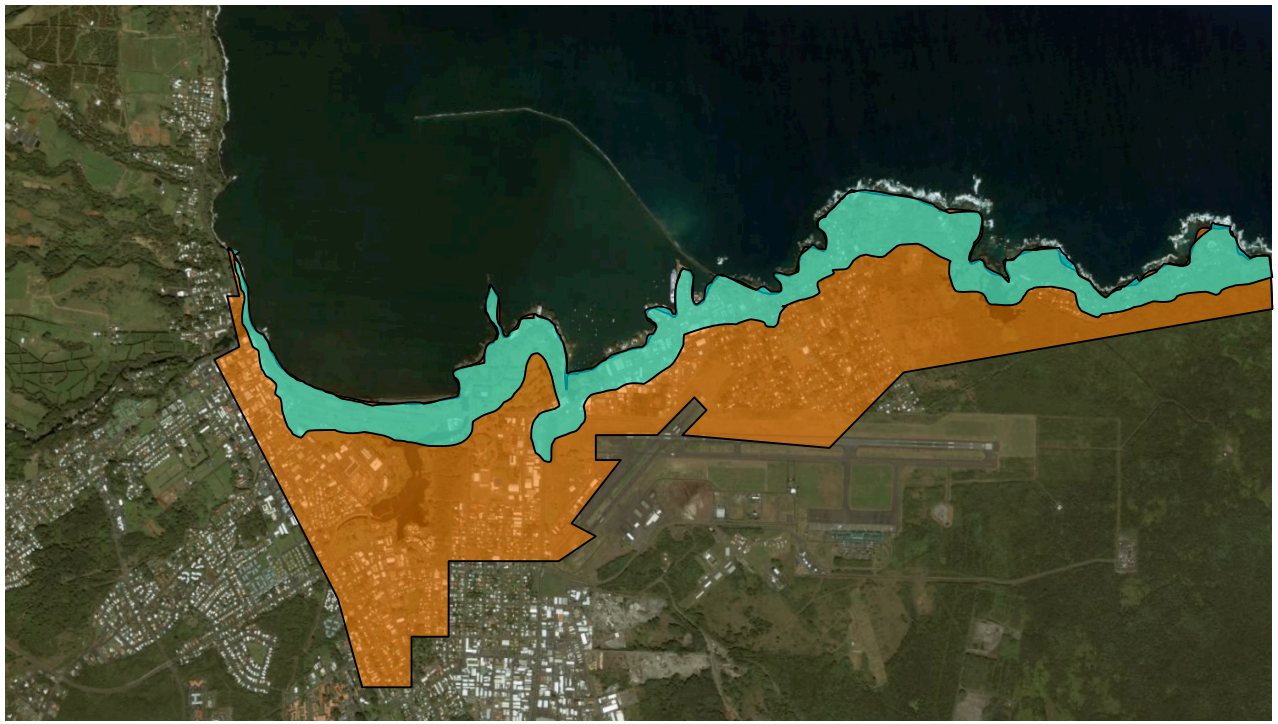
Hypothetical Short-term Forecast

Tsunami Evacuation Zones





Short versus Long-term forecast inundation at Hilo.



Who needs Long-term Forecasting?

60 year time-span:	NOAA (facilities life span)
100-500 year time-span:	Federal Emergency Management Agency (flood insurance maps)
10000 year time-span:	Nuclear Regulatory Commission (siting of nuclear power plants)
60-10000+ year time-span: Worst Case Scenario	States (tsunami evacuation maps)

NOAA Strategic Plan: Improve predictability of the onset, duration, and impact of hazardous severe weather and water events.

NOAA Research Plan: Improve NOAA's understanding and forecast capability in coasts, estuaries, and oceans.

3-5 Year Milestone: Improve tsunami warnings with emphasis on run-up and inundation, and reducing false alarms.

How is Long-term Forecasting performed at PMEL?

1-Use of tested and validated tsunami numerical model.
(Standards, Criteria and Procedures for NOAA Evaluation of Tsunami Numerical Models (NOAA Tech Memo OAR PMEL-135)).

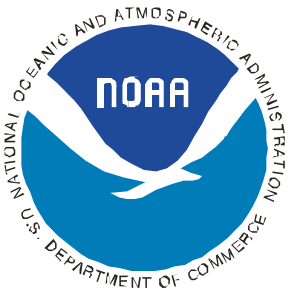
2-Development of high resolution, state of the art digital elevation models. (10 to 30 meter resolution topo/bathy models).

3-Data acquisition and validation with historical events.
(Tsunami deposits, tide gauge data, selection of probabilistic sources).

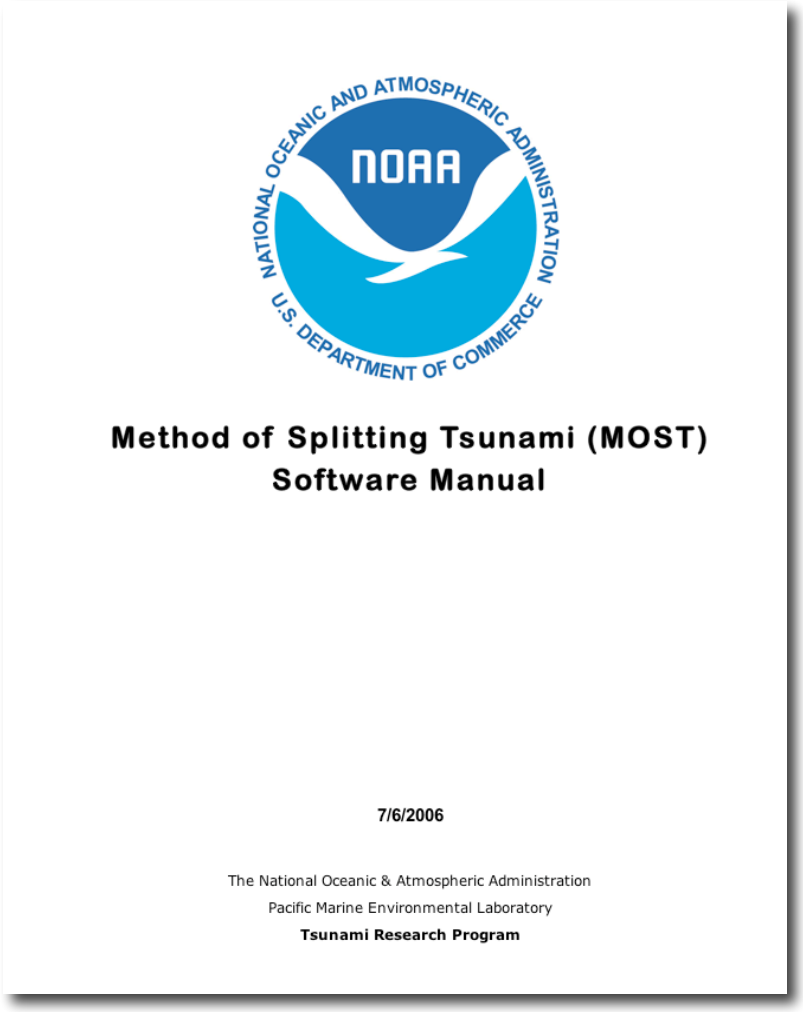
4-Analysis and interpretation of the results. (NOAA Technical Memorandum).

Long-term Forecast:

- *Deterministic Approach* *(Pearl Harbor Study)*
- *Probabilistic Approach* *(Seaside Pilot Study)*



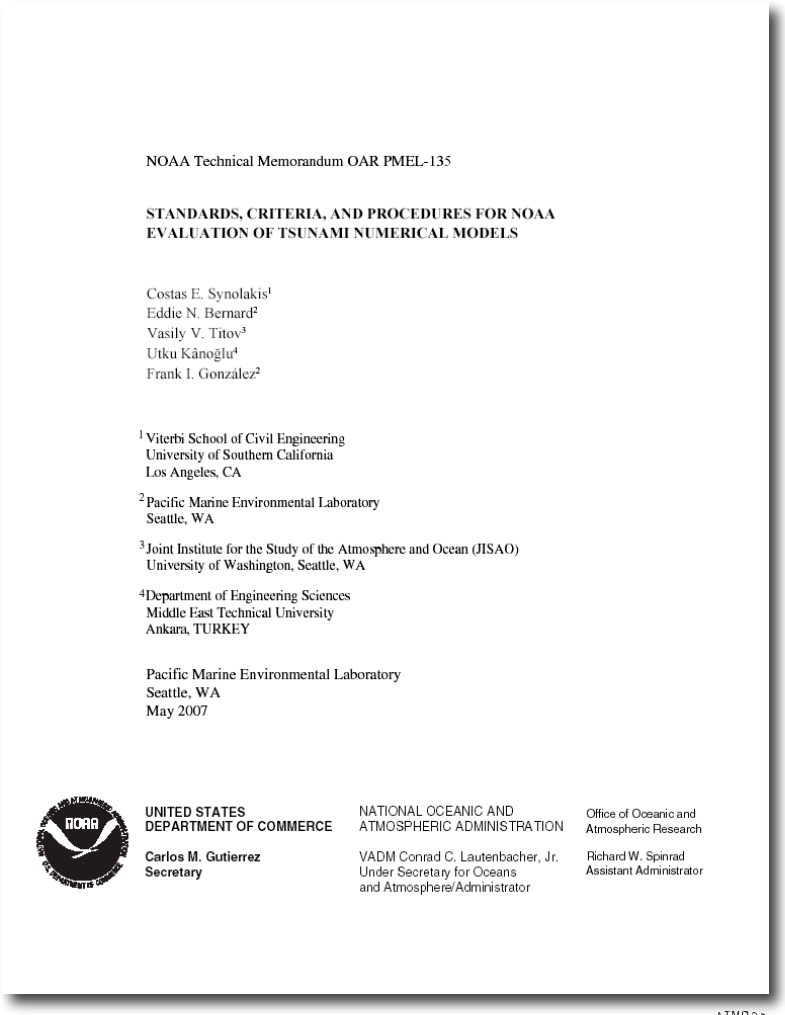
1- Validated Numerical Code



Method of Splitting Tsunami (MOST)
Software Manual

7/6/2006

The National Oceanic & Atmospheric Administration
Pacific Marine Environmental Laboratory
Tsunami Research Program



NOAA Technical Memorandum OAR PMEL-135

STANDARDS, CRITERIA, AND PROCEDURES FOR NOAA EVALUATION OF TSUNAMI NUMERICAL MODELS

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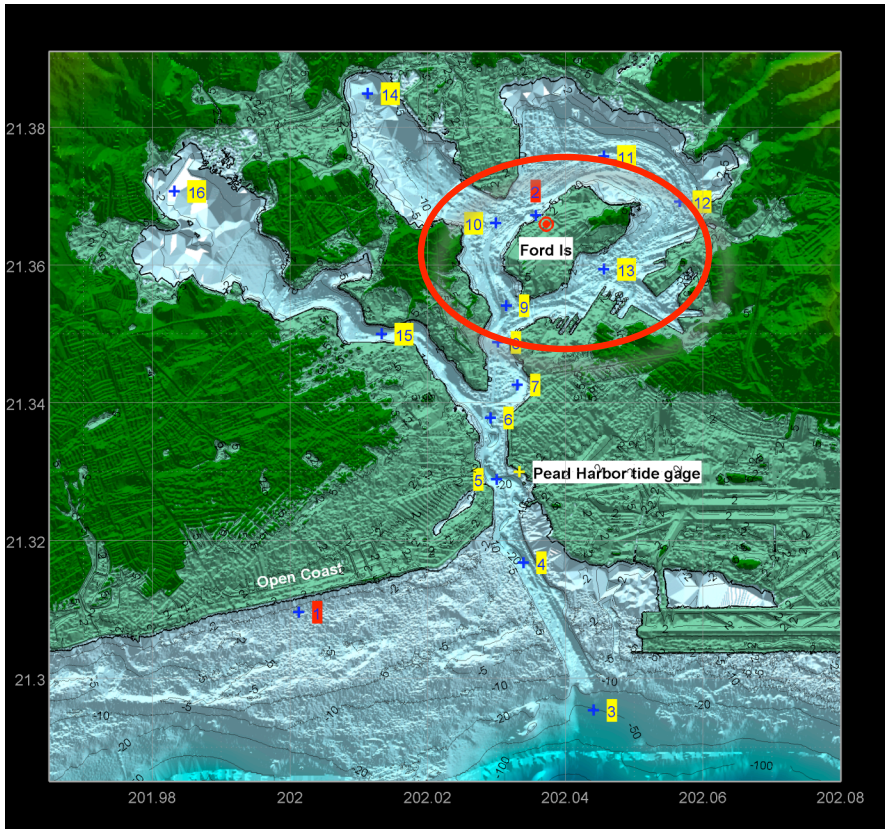
May 2007

UNITED STATES DEPARTMENT OF COMMERCE
Carlos M. Gutierrez
Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
VADM Conrad C. Lautenbacher, Jr.
Under Secretary for Oceans and Atmosphere/Administrator

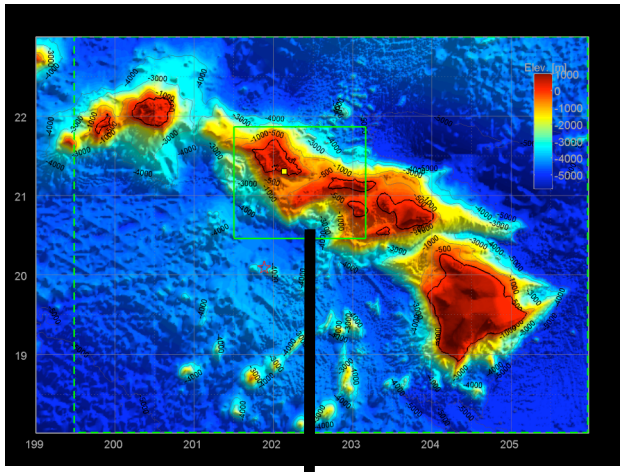
Office of Oceanic and Atmospheric Research
Richard W. Spinrad
Assistant Administrator

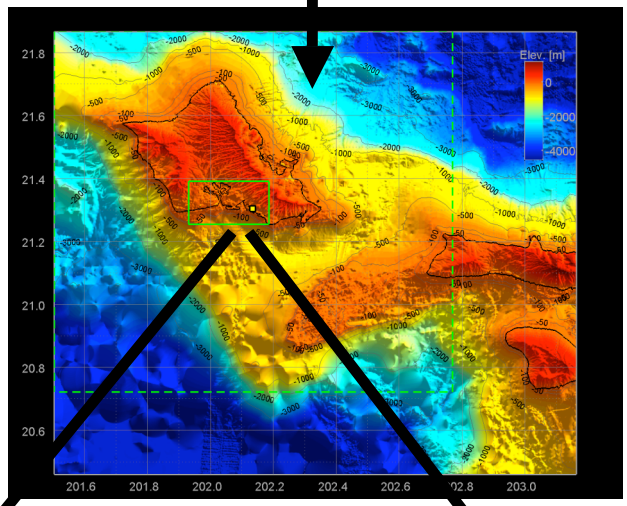
Relocation of emergency facilities and vital infrastructure: NOAA's Pacific Tsunami Warning Center



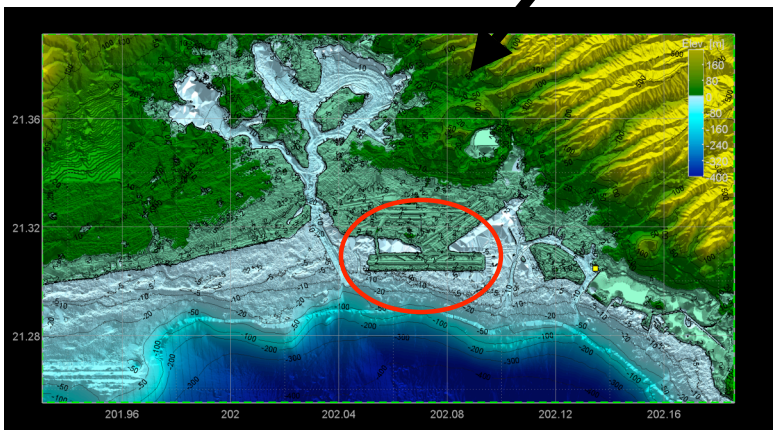
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

3- Data Acquisition for Model Validation

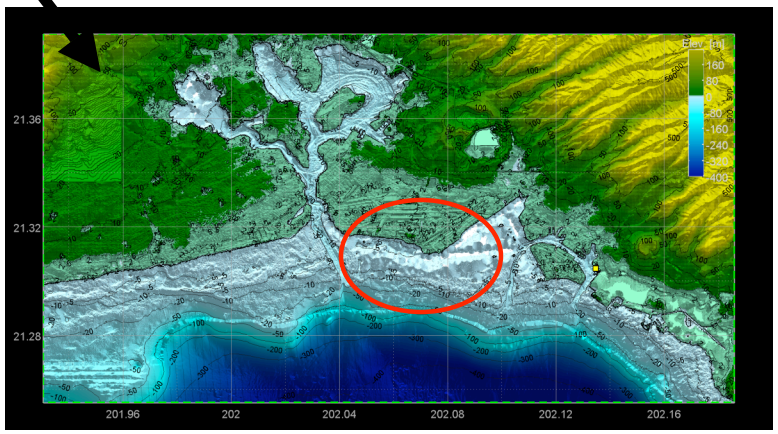




2006 DEM



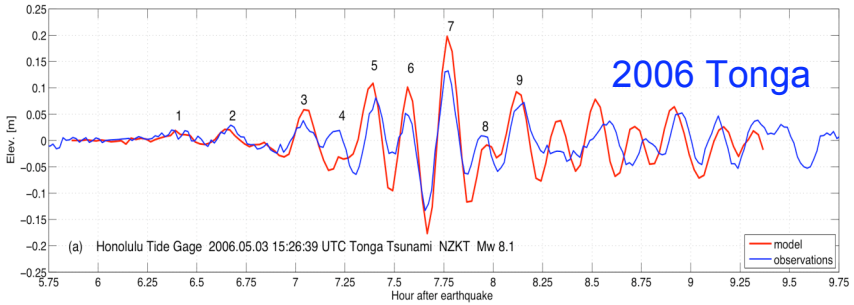
1960 DEM

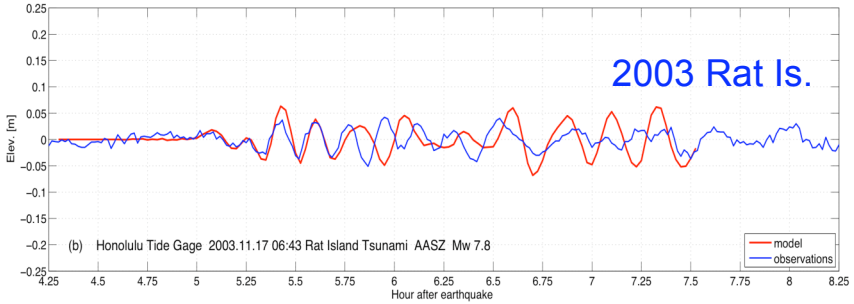


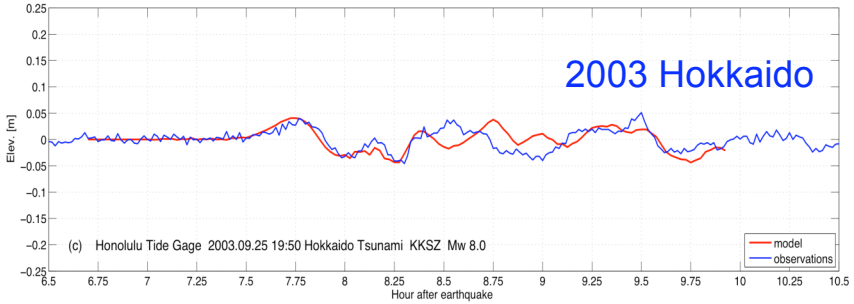
3- Data Acquisition for Model Validation.

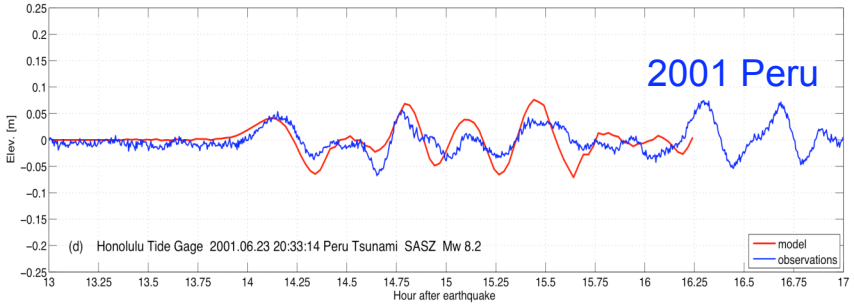
Sources computed from DART observations available for recent events.

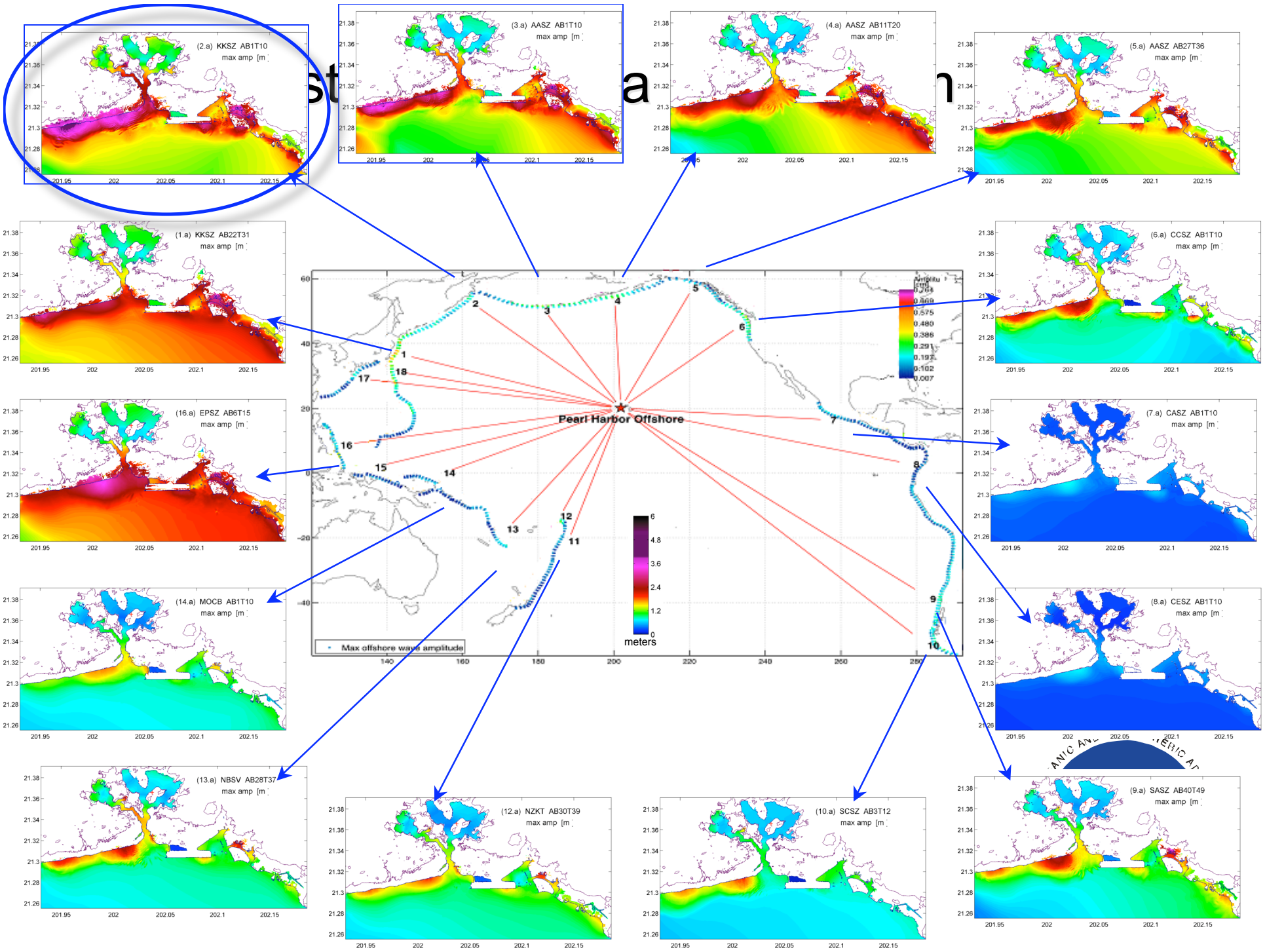
observations
model





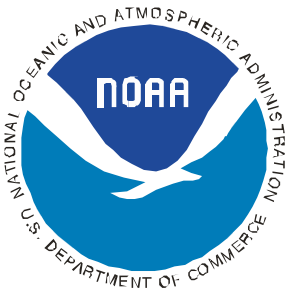




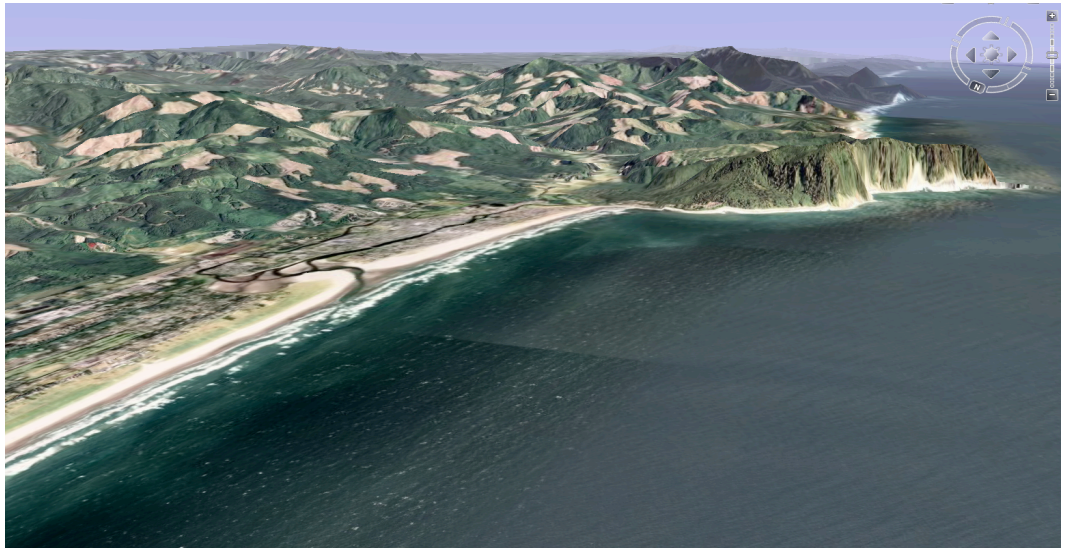

(2.a) KKSZ AB1T10
max amp [m]
(3.a) AASZ AB1T10
max amp [m]
(4.a) AASZ AB11T20
max amp [m]
(5.a) AASZ AB27T36
max amp [m]
(1.a) KKSZ AB22T31
max amp [m]
(6.a) CCSZ AB1T10
max amp [m]
(16.a) EPSZ AB6T15
max amp [m]
(7.a) CASZ AB1T10
max amp [m]
(14.a) MOCB AB1T10
max amp [m]
(8.a) CESZ AB1T10
max amp [m]
(13.a) NBSV AB28T37
max amp [m]
(12.a) NZKT AB30T39
max amp [m]
(10.a) SCSZ AB3T12
max amp [m]
(9.a) SASZ AB40T49
max amp [m]
Pearl Harbor Offshore
Max offshore wave amplitude
meters

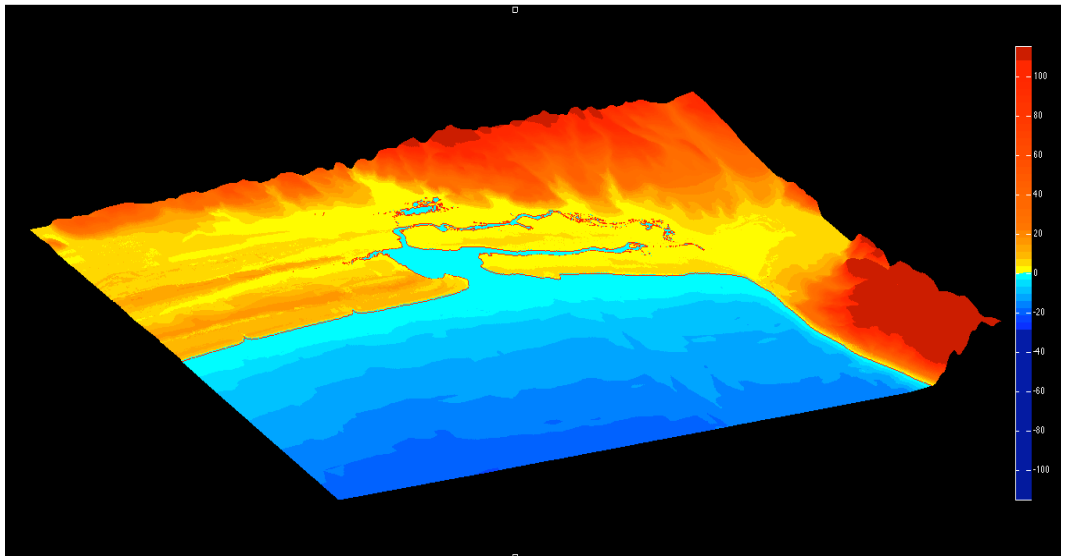
Long-term Forecast:

- *Deterministic Approach* *(Pearl Harbor Study)*
- *Probabilistic Approach* *(Seaside Pilot Study)*



2- Development of a high resolution Digital Elevation Model



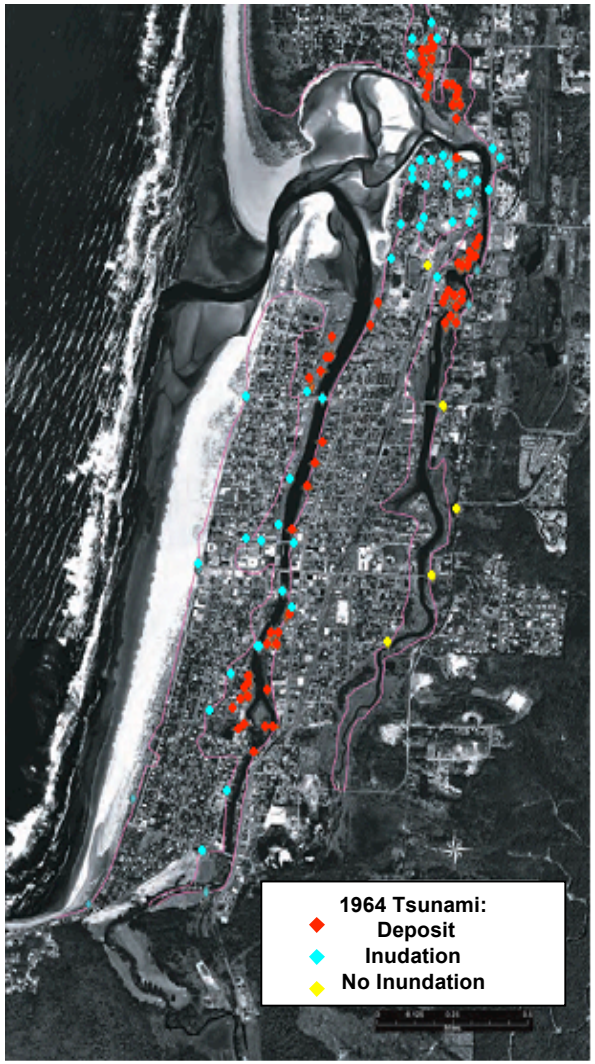


-1/3 arc sec resolution is necessary for high quality simulations.

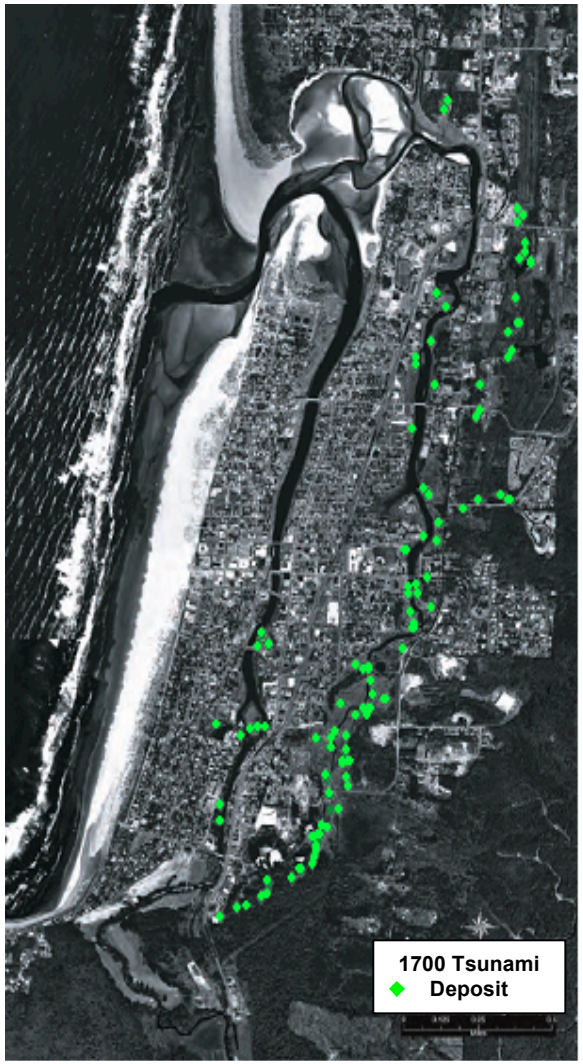
-Grids should cover deep (1000 m) and shallow areas.

-DEM is generated in partnership with NGDC, USGS…

3- Data Acquisition for Model Validation



1964 Alaska



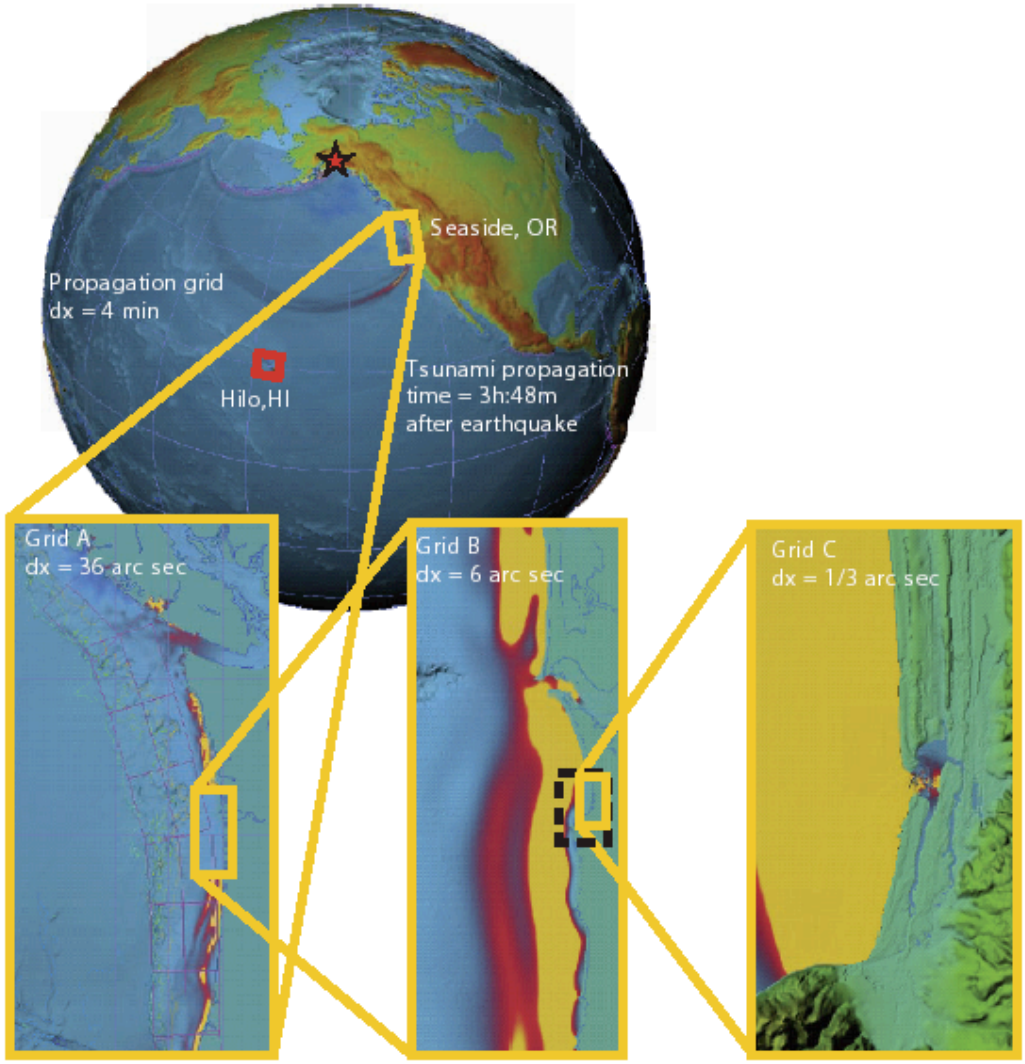
1700 Cascadia

-No tide gauge available.

-Tsunami deposits and eye-witness reports provided needed validation data.

-Source available for the 1964 event inverted from HI gauges.

3- Data Acquisition for Model Validation

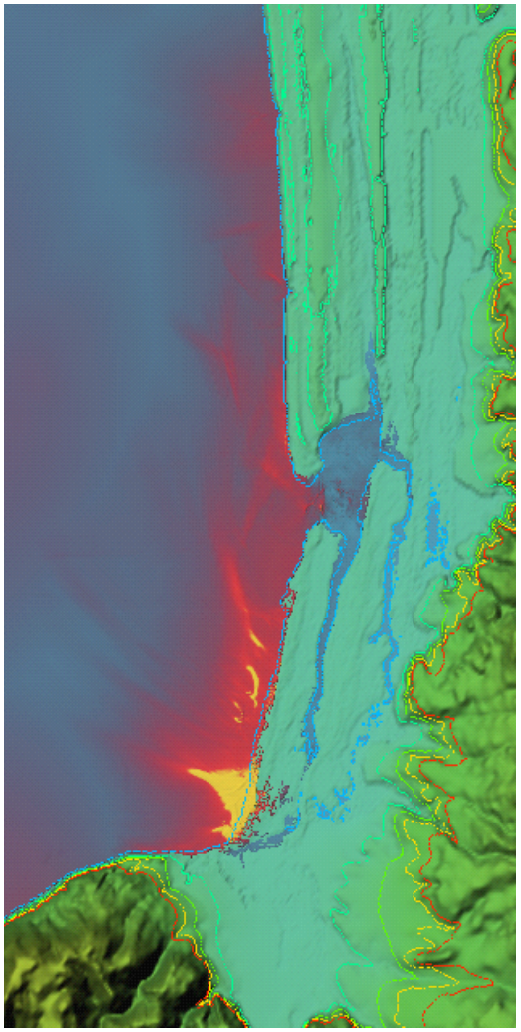


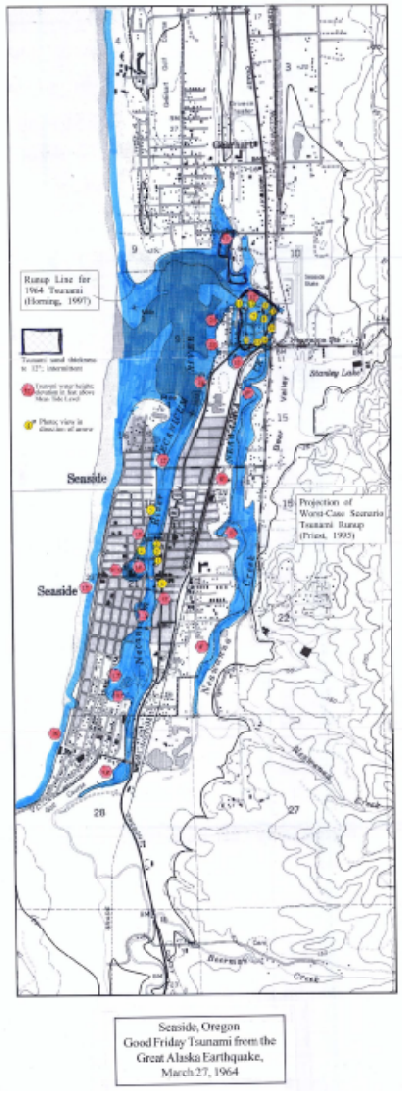
March 28, 1964 Alaskan Tsunami

Model comparisons:

- Inundation field data at Seaside, Oregon
- Tide gage measurement at Hilo, Hawaii

3- Data Acquisition for Model Validation



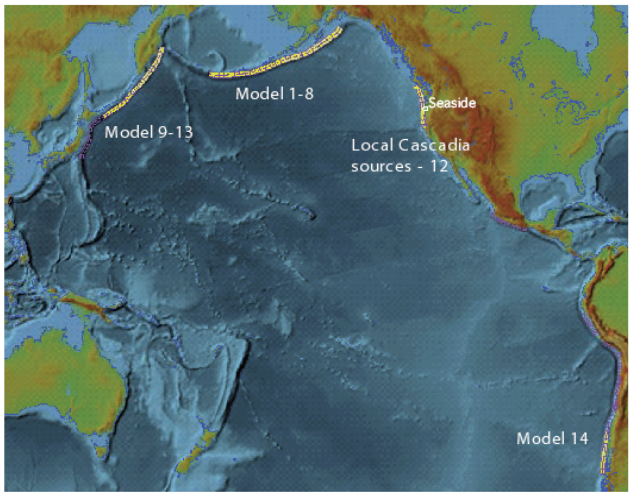


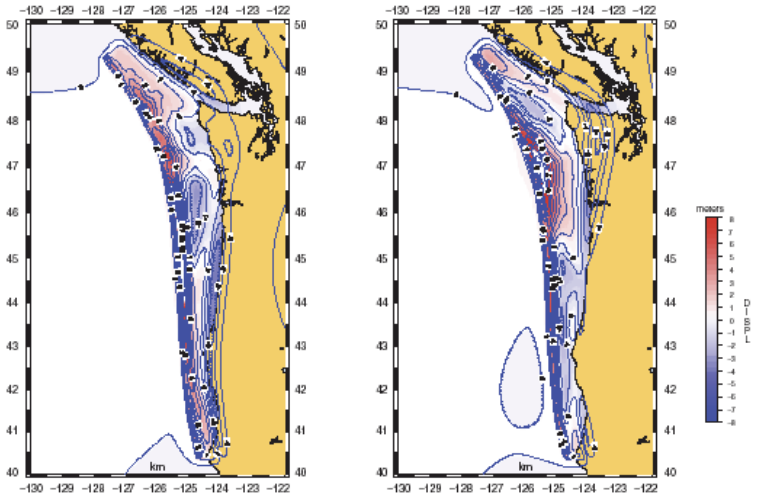
1964 tsunami at Seaside

Eyewitness reports of the 1964 tsunami inundation at Seaside (compiled and measured by T. Horning) are the best available tsunami field data for this location. The inundation field measurements were compared with tsunami simulation results to ensure accuracy of tsunami inundation predictions. The test showed that high-resolution grid of at least 10m resolution is required for the Seaside tsunami inundation model.

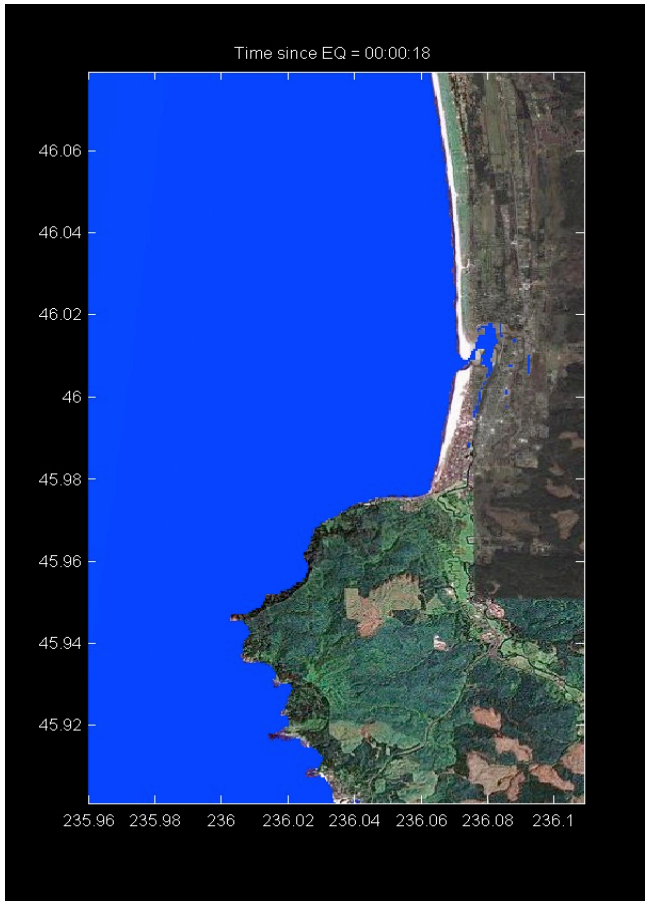
Probabilistic Simulations

An ensemble of potential sources is selected



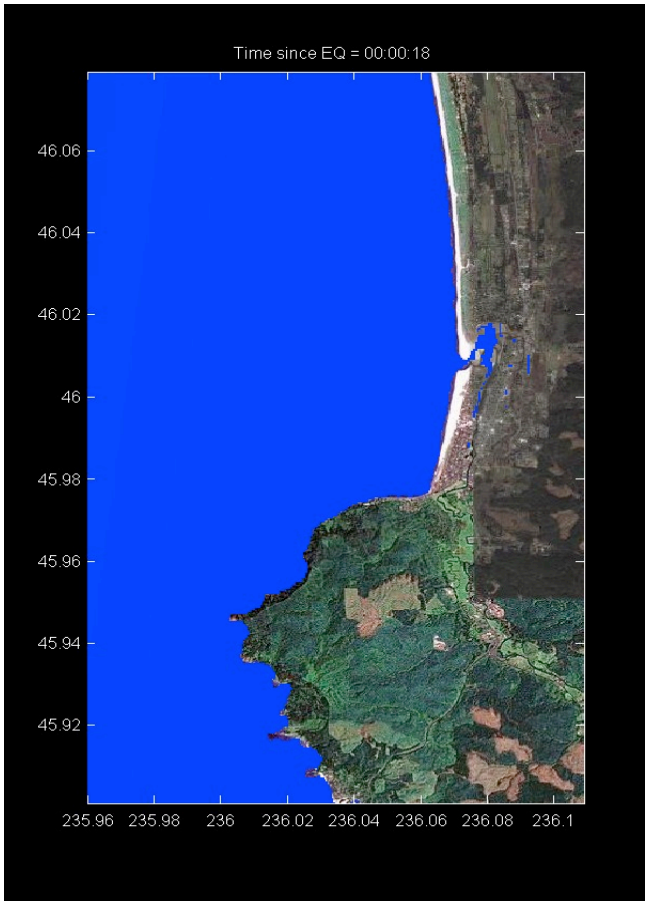


The associated tsunami is modeled

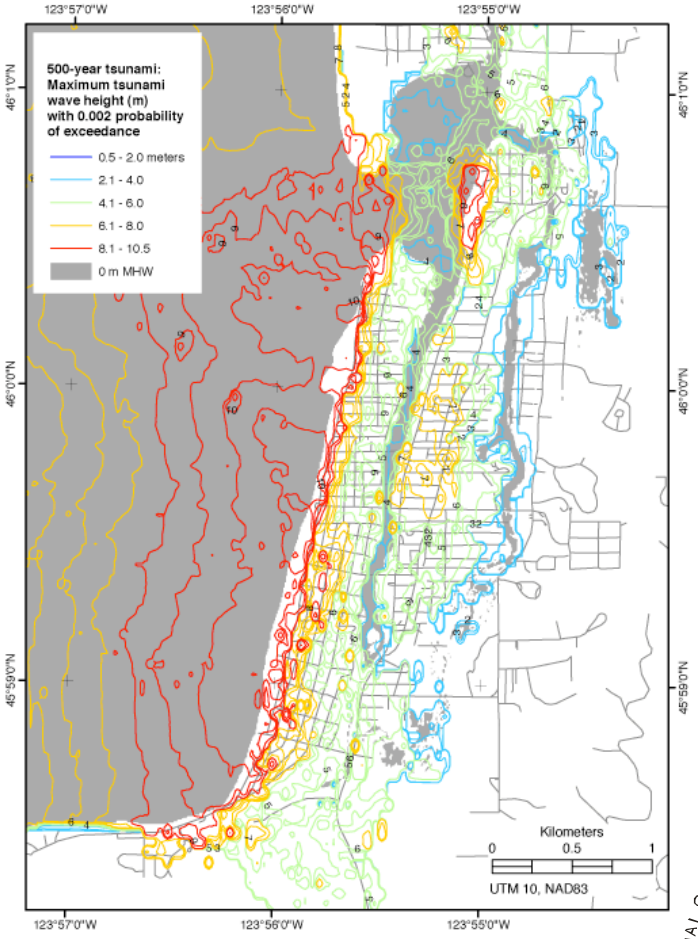


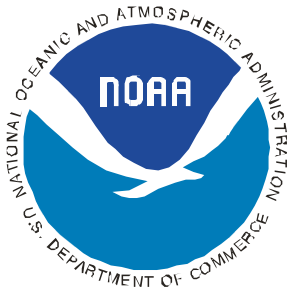
500 Year Tsunami Map

The associated tsunami is modeled



Tsunami inundation probability is inferred

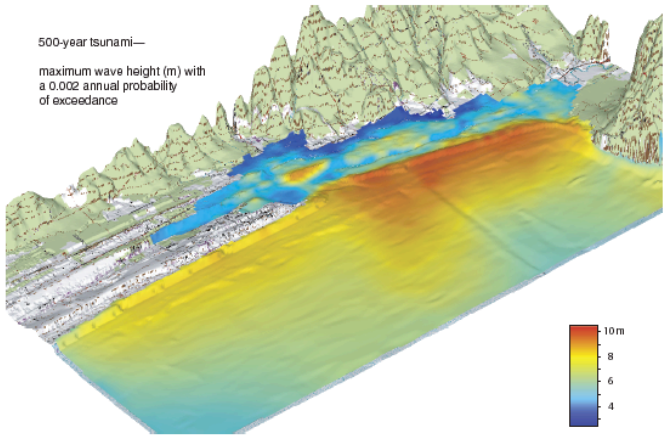




4-Product Generation: Recommedations Report, Tsunami Evacuation Maps

Seaside, Oregon Tsunami Pilot Study—Modernization of FEMA Flood Hazard Maps

By Tsunami Pilot Study Working Group



Joint NOAA/USGS/FEMA Special Report

U.S. National Oceanic and Atmospheric Administration
U.S. Geological Survey
U.S. Federal Emergency Management Agency

USGS science for a changing world

FEMA

IF YOU FEEL THE GROUND SHAKE, MOVE QUICKLY TO HIGHER GROUND AND SAFETY! DO NOT WAIT FOR AN OFFICIAL WARNING!

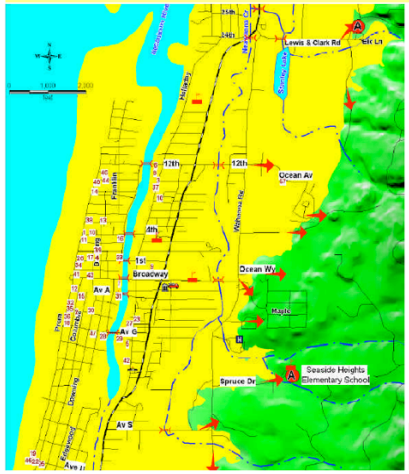
TSUNAMI EVACUATION ROUTE

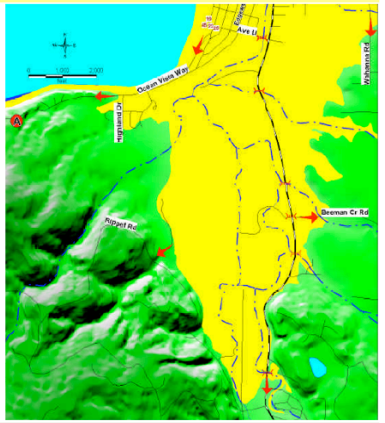
NOTICE

The evacuation zone on this map was developed by the Oregon Department of Geology and Mineral Industries in consultation with local officials. It is intended to represent a worst-case scenario for a tsunami caused by an undersea earthquake near the Oregon coast. Evacuation routes were developed by local officials and reviewed by the Oregon Department of Emergency Management.

The Oregon Department of Geology and Mineral Industries is publishing this brochure because the information furthers the mission of the Department. The map is intended for emergency response and should not be used for site-specific planning.

Tsunami Evacuation Map Seaside





A BROWN band near the top of a street sign indicates that you are in the tsunami hazard zone. A GREEN band on a street sign indicates that you are outside the hazard zone — FOR A LOCAL TSUNAMI. (See other side about local vs. distant tsunamis).

LEGEND

Evacuation Zone
Evacuation Route
School
Fire Station
Police Station
City Hall
Assembly Area
Hospital
Bridge
18 Motel (see list)

MOTELS

1 Best Western Ocean View Resort
2 Budget Inn
3 Bungalow City Motel
4 City Center Motel
5 Coast River Inn
6 Colonial Motor Inn
7 Comfort Inn Boardwalk
8 Country River Inn
9 Custer B & B/Cottages
10 Driftwood Motel
11 Ebb-Tide Motel
12 Edgewater Inn at the Prom
13 Fifth Avenue Motel
14 Four Winds Motel
15 Gilbert Inn B & B
16 The Guest House B & B
17 Hillcrest Inn
18 Hi-Tide Motel
19 Inn At The Shore
20 The Lanai
21 Mariner Motel
22 Microtel Inns & Suites
23 Mirage Condo/Motel
24 Motel 6 of Seaside
25 Night Cap Inn
26 Ocean Front Motel
27 Riverside Inn B & B
28 Riverside West Cottages
29 River View Inn
30 Rogers Inn
31 Royale Motel
32 Sand & Sea
33 Seaside Convention Center Inn
34 Seashore Resort Inn
35 Seaside Beach Club
36 Seaside Inn B & B
37 Seaside International Hostel
38 Seasider Motel
39 Seasider II Motel
40 Seaview Inn
41 Shilo Ocean Front
42 Shilo Suites East
43 Sundowner Motor Inn
44 Tenth Avenue B & B
45 The Tides
46 Tradewinds Motel
47 Weiss' Paradise Motel

http://nctr.pmel.noaa.gov/education/science/docs/tsun2975/tsun2975_front_matter.pdf

Summary

- *The relevance of Long-term Forecast is underlined by the variety of its applications as reflected in the diversity of "customers" and collaborating institutions: NOAA, FEMA, NRC, Washington State….*
- *PMEL's Methodology ensures quality of the study by using : Validated numerical model, high resolution DEMs, site-specific validation calculations.*
- *PMEL's Methodology optimizes the performance and enhances the quality via the use of operational forecasts tools: Propagation database, Stand-by Inundation Models.*